

# PLANT PARASITIC NEMATODES IN FRUIT TREE NURSERIES OF NEW SOUTH WALES

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## *Synopsis*

Soil samples taken from under 11 kinds of fruit trees in 20 nurseries and from a few bearing orchards in New South Wales, were examined for plant parasitic nematodes. Spiral nematodes (*Helicotylenchus* spp.) were present in all areas and associated with all root stocks examined. Root lesion nematodes (*Pratylenchus* spp.) were also widely distributed. Stubby root nematodes (*Trichodorus* spp.) were more prevalent in Gosford than in other districts and were associated with *Citrus* spp. The citrus nematode (*Tylenchulus semipenetrans* Cobb) was found in one quarter of the samples examined from citrus at Gosford and Sydney, in one sample of fallow soil and in a young orange planting in the Murrumbidgee Irrigation Areas (M.I.A.) established from plants imported from Gosford. Stylet nematodes (*Tylenchorhynchus* spp.) were found only in the M.I.A., and dagger nematodes (*Xiphinema* spp.) were found infrequently in the Gosford, Sydney and M.I.A. districts. The citrus, root lesion and stubby root nematodes were present sufficiently often to pose a threat to new orchards planted with stocks from infested nurseries.

## INTRODUCTION

A few samples of soil taken from a nursery near Gosford, New South Wales (N.S.W.), by the author in 1957 yielded many nematodes known to be parasitic on the roots of plants. Such nematodes were found also in samples of soil taken from areas then growing either native bush or grasses and from cultivated areas devoted to forage, fruit and vegetable crops. These collections were studied by Drs. M. W. Allen and R. C. Colbran at the University of California, U.S.A., who confirmed the author's identifications. Included in these collections were 15 species in nine genera known, or thought to be plant parasites. Either larvae or insignificant numbers of adults of four other genera known to contain plant parasites were found. Table 1 lists the nematodes and the plants with which they were associated.

The presence of the genera *Meloidogyne*, *Pratylenchus*, *Radopholus* and *Tylenchulus* species, which live within roots, and of *Helicotylenchus* and *Rotylenchus* spp., which are not always removed when roots are washed, raised the question whether these nematodes are introduced to new orchard areas with nursery stock.

## METHODS

Samples of soil and small roots were taken to a depth of six to eight inches after the top one to two inches of soil had been removed. Most samples, each of about 500 ml., were treated separately, but a few from two or more sites along a nursery row were bulked before treatment. Nurseries near Gosford, Sydney, Bathurst, Orange, Griffith, Leeton and Yanco were sampled. In addition, five young orchards and three "virgin" or long fallow areas were sampled. About 300 samples were collected between October 1 and December 11, 1964.

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TABLE 1

*Plant parasitic nematodes in soil samples collected in New South Wales in 1957*

Nematode	Plants with which associated
<i>Criconema</i> sp.	orange
<i>Criconemoides mutabile</i> Taylor	maize on old grassland
<i>Criconemoides xenoplax</i> Raski	peach, cowpea
<i>Criconemoides</i> sp.	<i>Casuarina</i> sp.
<i>Helicotylenchus multicinctus</i> Cobb	Kikuyu grass, peach, <i>Eucalyptus pihularis</i>
<i>Helicotylenchus nannus</i> (Steiner) Andrassy	banana, <i>Casuarina</i> sp., <i>Cynodon</i> sp., <i>Datura</i> sp., grape, nectarine, orange, pineapple, strawberry
<i>Hemicyclophora</i> sp.	banana, maize, <i>Eucalyptus maculata</i> , <i>E. pihularis</i>
<i>Heterodera</i> sp.	<i>Casuarina</i> sp.
<i>Meloidogyne javanica</i> (Treub) Chitwood	Kikuyu grass
<i>Meloidogyne</i> sp.	banana, strawberry
<i>Paratylenchus</i> sp.	asparagus, maize, orange, peach, tobacco
<i>Pratylenchus minyus</i> Sher and Allen	tomato
<i>Pratylenchus thornei</i> Sher and Allen	cauliflower
<i>Pratylenchus</i> sp.	lucerne
<i>Radopholus similis</i> (Cobb) Thorne	banana, Kikuyu grass, pineapple
<i>Rotylenchus brachyurus</i> Steiner	grape
<i>Rotylenchus robustus</i> (de Man) Filipjev	<i>Eucalyptus</i> sp. and mixed grasses
<i>Rotylenchus</i> sp.	mixed grasses
<i>Trichodorus minor</i> Colbran	asparagus, banana, Bermuda grass, <i>Casuarina palulosa</i> , <i>Datura</i> sp., grape, nectarine, orange, pineapple, strawberry
<i>Trichodorus porosus</i> Allen	<i>Casuarina</i> sp., <i>Eucalyptus</i> sp., nectarine, peach
<i>Trichodorus</i> sp.	peach, pineapple, <i>Eucalyptus</i> sp.
<i>Tylenchulus semipenetrans</i> Cobb	orange (on sour lemon stock)
<i>Tylenchorhynchus brevidens</i> Allen	lucerne
<i>Tylenchorhynchus latus</i> Allen	cauliflower
<i>Tylenchorhynchus</i> sp.	strawberry

Nematodes were extracted from 250 ml. of soil by either an elutriator (Seinhorst, 1956) or a flotation method (Jenkins, 1964). These methods yielded comparable results and were used interchangeably. The nematodes were killed by heating in a water bath to 125°F and preserved in 4% formalin. For all observations reported the nematodes were recovered from the soil samples within 10 days of being collected.

## RESULTS

Tables 2 and 3 show marked differences in the distribution of nematodes between nurseries. Some nurseries grew citrus, others predominantly stone or pome fruits, while others grew all of these. Thus, it is difficult to separate the effects of host and location on nematode infestation. Some species appear to be widely distributed and others more restricted both as to district and host. The species, in so far as they could be determined, the plants with which they were associated, and the districts in which they were found are summarized.

*Criconemoides teres* Raski was found in a sample of "virgin" soil near Gosford and in apple, peach and orange (*Poncirus trifoliata* stocks) nursery rows near Sydney. *Criconemoides* sp. larvae also were found in the Gosford and M.I.A. districts associated with *P. trifoliata* stocks and in a plum seedling planting near Sydney.

*Helicotylenchus nannus* (Golden) Perry was associated with *P. trifoliata* stocks, grapefruit, orange, pear and plum plantings and in "virgin" soil in the Gosford district, and with all these plants as well as apple, lemon, walnut and in fallow soil near Sydney. In the Bathurst-Orange district it was found in plantings of apple and peach seedlings. *H. multicinctus* (Cobb) Golden was found near Gosford in a planting of *P. trifoliata* seedlings and, near Sydney,

TABLE 2

*Distribution of principal genera of plant parasitic nematodes in fruit tree nurseries of New South Wales*

Nursery plant and District	Number of Samples Infested							Number of samples examined	
	<i>Cricemoides</i>	<i>Helicotylenchus</i>	<i>Paratylenchus</i>	<i>Pratylenchus</i>	<i>Trichodorus</i>	<i>Tylenchorhynchus</i>	<i>Tylenchulus</i>		<i>Xiphinema</i>
Apple									
Sydney	2	14	—	4	1	—	—	2	15
Bathurst—Orange	—	8	—	5	—	—	—	—	26
M.I.A.*	—	8	4	12	—	4	—	1	14
Apricot									
Sydney	—	6	1	—	—	—	—	—	6
M.I.A.	—	5	2	5	1	8	—	1	12
Cherry									
Sydney	—	3	4	1	—	—	—	—	4
Bathurst—Orange	—	1	—	—	—	—	—	—	2
Citrus									
Gosford	1	29	2	6	33	—	8	—	42
Sydney	4	45	1	4	4	—	14	4	49
M.I.A.	2	2	1	3	2	1	—	1	6
Grape									
M.I.A.	—	2	—	2	1	—	—	2	8
Mulberry									
Sydney	—	2	—	1	—	—	—	—	2
Nectarine									
Sydney	—	2	—	—	—	—	—	—	2
M.I.A.	—	2	—	3	1	—	—	—	3
Peach									
Sydney	4	14	—	1	—	—	—	2	14
Bathurst—Orange	—	6	—	3	—	—	—	—	8
M.I.A.	—	2	5	7	—	5	—	—	20
Pear									
Gosford	—	2	—	1	2	—	—	—	2
Sydney	—	6	—	—	—	—	—	—	7
Bathurst—Orange	—	2	—	1	—	—	—	—	6
M.I.A.	—	—	—	2	1	—	—	—	2
Plum									
Gosford	—	2	—	1	2	—	—	—	14
Sydney	1	10	—	3	—	—	—	—	13
Walnut									
Sydney	—	2	—	1	—	—	—	—	2
M.I.A.	—	1	—	2	—	2	—	1	2

\* Murrumbidgee Irrigation Areas

TABLE 3

Principal genera of plant parasitic nematodes in soils from bearing orchards and "virgin" or fallow areas

Source	<i>Criconeimoides</i>	<i>Helicotylenchus</i>	<i>Paratylenchus</i>	<i>Pratylenchus</i>	<i>Trichodorus</i>	<i>Tylenchorhynchus</i>	<i>Tylenchulus</i>	<i>Xesthenema</i>	Number of samples examined
Apple									
Sydney	—	6	—	6	—	—	—	1	6
Bathurst-Orange	—	1	—	—	—	—	—	—	3
Orange									
Gosford	—	2	—	2	2	—	2	—	2
M.I.A.*	1	2	4	10	10	—	2	7	17
"Virgin" soil or fallow									
Gosford	1	4	—	—	—	—	—	—	4
Sydney	—	7	—	1	—	—	1	—	7
M.I.A.	—	1	—	2	—	—	—	1	2

\* Murrumbidgee Irrigation Areas

in plantings of peach and plum. In addition, *Helicotylenchus* sp. larvae were found in a planting of walnut at Sydney, plantings of apple and pear near Bathurst, in lemon, nectarine and peach plantings and in fallow soil in the M.I.A. *Helicotylenchus* spp., therefore, were found more frequently and associated with a larger number of plants in the Gosford and Sydney districts than in the M.I.A.

*Paratylenchus nanus* Cobb was found only in the M.I.A. and was associated with apple, apricot, peach and *P. trifoliata* stocks. A few specimens of *Paratylenchus* sp. were found near Gosford associated with citrange stocks, near Sydney with lemon and cherry, and in the M.I.A. with apricot.

The genus *Pratylenchus* was represented by many species and was widely distributed. *P. coffeae* (Zimmerman) Goodey was associated with apple and peach near Bathurst, with apricot in the M.I.A., and with apple, cherry and mulberry near Sydney. *P. minyus* Sher and Allen was associated with plum at Gosford, apple, lemon, peach and plum near Sydney, with apple at Bathurst, and with apple, apricot, grape, lemon, nectarine, peach, pear, *P. trifoliata* stocks and walnut in the M.I.A. *P. penetrans* (Cobb) Chitwood and Oteifa was seen only in a collection from apple in the M.I.A. *P. zaei* Graham was associated with apple, cherry, lemon and *P. trifoliata* stocks and in fallow land near Sydney, and with peach and pear in the Bathurst-Orange district. Specimens of *Pratylenchus* which could not be further identified were found associated with lemon, *P. trifoliata* and orange stocks at Gosford, with apple, apricot and cherry at Sydney, and with apple, apricot and peach in the M.I.A.

*Trichodorus minor* Colbran was found associated with apple and lemon near Gosford and with apricot, peach, pear and *P. trifoliata* in the M.I.A. *T. porosus* Allen was associated at Gosford with citrange, lemon, orange, *P. trifoliata* and pear stocks, near Sydney with lemon and orange, and in the M.I.A. with apricot, grape, orange and *P. trifoliata*. *T. teres* Hooper was associated with citrus at Gosford. Specimens of *Trichodorus*, the species of which could not be determined, were found at Gosford in grapefruit and plum plantings, at Sydney in fallow soil, and in the M.I.A. in plantings of lemon and orange.

Specimens of *Tylenchorhynchus* which appeared to be *T. brevidens* Allen were associated with apple, apricot, grape, peach and walnut in the M.I.A. and in the same area *Tylenchorhynchus* sp. was found in a planting of *P. trifoliata* stocks.

Larvae of *Tylenchulus semipenetrans* Cobb were found in large numbers in soil from nursery rows of citrange, lemon and orange seedlings and from an orange grove near Gosford, in soil from rows of lemon, orange and *P. trifoliata* as well as a fallow area near Sydney, and from three young orange plantings on stocks of rough lemon, orange and *P. trifoliata* near Yanco in the M.I.A. The young trees in the latter plantings were said to have been grown from seed at Gosford.

*Xiphinema americanum* Cobb was found in small numbers in soil from rows of apple and peach stocks near Sydney and from grape, *P. trifoliata* and walnut in the M.I.A. *Xiphinema* spp. were found also in soil from apple and *P. trifoliata* rows near Sydney, and from apple, apricot and grape in the M.I.A.

A few specimens of larvae or lone adults of *Belonolaimus* (Sydney: plum), *Hemicycliophora* (Gosford: "virgin" soil), *Hoplolaimus* (Sydney: pear), *Longidorus* (Sydney: apple, peach and pear), *Meloidogyne* (Sydney: peach and fallow), *Rotylenchus* (Gosford: *P. trifoliata*; Sydney: peach and fallow) and *Tylenchus* (Sydney: peach; M.I.A.: apple and peach) were found. These are considered incidental.

#### DISCUSSION

The failure to find a nematode species in a few samples does not necessarily indicate that it is not present in the area or that the plant in question is not a host. However, its absence or rare occurrence in one area or crop as opposed to another can be taken to indicate that it probably does not exist there in serious numbers because it has not been introduced, has been introduced only recently, or the plants in the area are not suitable hosts for its rapid reproduction. Proper interpretation of the observations presented here requires knowledge of the host range and the pathogenicity of the nematodes on the various crop plants. Such information is at present lacking. Many of the nurseries are infested with weeds which may be better hosts than the crop plant. Thus, numbers of nematodes per soil sample may not be meaningful unless the nematode in question is known to be pathogenic on the crop plant. Finally, the determination of species sometimes is questionable because authentic slides for comparison were unavailable.

Relatively few nematodes were found in samples from the Bathurst-Orange district. This district had been unusually wet for several weeks before the samples were collected. Some sites had been flooded and all were nearly saturated with water when sampled. Thus, the results from this district may not be valid.

The genus *Helicotylenchus* was ubiquitous, occurring in more than half of the samples and in 12 of the 13 samples from "virgin" or long fallow soils examined. Golden (1956) showed that *R. buxophilus* was pathogenic on boxwood, but the significance of this genus in this study is unknown. On pineapple in Hawaii special nematodes appear to cause limited injury, but they are so widespread that control measures in the nursery alone would not be justified.

The genus *Pratylenchus* (root lesion nematodes) is also widespread. One or more species were found in all four districts and associated with all crops sampled. *P. minyus* Sher and Allen was found also in fallowed soil in the M.I.A. Colbran (1953) showed that *P. coffeae* causes serious injury to apples in Queensland, while Seinhorst and Sauer (1956) found *P. scribneri* and *P. vulnus* attacking grapes in Victoria. Because this genus is pathogenic and widespread, it poses a threat to new orchard plantings and warrants control measures being considered.

Species of the genus *Trichodorus* (stubby root nematodes) which were found in three-quarters of the samples from citrus nurseries in the Gosford district, in fewer nurseries in the Sydney and M.I.A. districts, but again associated with citrus. Stubby roots symptoms in citrus were seen frequently in this study. The genus contains known parasitic species and an attempt should be made to prevent its spread to new citrus planting.

The citrus nematode (*Tylenchulus semipenetrans* Cobb) has been recognized as a pathogen in citrus and grapes in Australia for some time (Seinhorst and Sauer, 1956; Sauer, 1962). In this study it was found in nurseries in the Gosford and Sydney districts, in an orange orchard near Gosford, and in the M.I.A. The trees with which it was associated in the M.I.A. were raised at Gosford. It was not associated with other crops, but was recovered from a fallow soil at the border of a nursery near Sydney. It is a serious pest in citrus and poses a threat to the yield from any planting made with infected nursery stock. It can be controlled in orchards but at a very much greater expense per tree than in the nursery. Every effort should be made to eliminate this nematode from nursery stock.

*Xiphinema* species (dagger nematodes) found infrequently in the Sydney and M.I.A. districts are of interest because the genus contains vectors of plant viruses. These nematodes and *Longidorus* spp. merit study, but do not appear to be a threat at present.

Other nematodes, *Belonolaimus*, *Criconemoides*, *Paratylenchus*, *Tylenchorhynchus* and *Tylenchus* were encountered infrequently and are not likely to be carried in nursery stocks.

A successful control measure for one of the more serious nematode pests in nurseries, such as the citrus nematode, is likely to control other nematodes at the same time. Studies of chemical treatment of the soil, treatment of lifted root stocks, with either a nematicide or heat or both, before sale, should be pursued vigorously.

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